

NATURAL HISTORY
SURVEY.

A REPORT ON TESTS OF FUNGICIDES
FOR THE CONTROL OF ELM DISEASES IN NURSERIES

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Biological Notes No. 4

Urbana, March 30, 1935

Contribution from the
Section of Applied Botany and Plant Pathology

In considering this report, it should be remembered that the use of sprays and dusts as fungicides has been developed almost entirely in connection with orchards and plants from which a fruit crop is taken. With these, the problem has been chiefly the prevention of those types of infection which recur, year by year, on the leaves, blossoms, and fruit and whose effect is apparent chiefly in damage to leaves or in ruination of fruit. The value of fungicides to trees which provide ornament and shade has been inadequately tested. Formerly spraying of trees was much recommended, because it ought to do them good; but now it is the general practice of tree experts to spray only when there is definite need. The data here presented are among the first to give light on the value of spraying young growing trees for disease prevention.

L. R. Tehon

THE JOURNAL OF THE
ROYAL ANTHROPOLOGICAL INSTITUTE
OF GREAT BRITAIN AND IRELAND

Vol. 41.

1911.

Part I.

THE JOURNAL OF THE ROYAL ANTHROPOLOGICAL INSTITUTE OF GREAT BRITAIN AND IRELAND, VOL. 41, PART I, 1911. PUBLISHED BY THE INSTITUTE, 21, BEDFORD SQUARE, LONDON, W.C.1.

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3.--Dry Wettable Flotation Sulfur. This sulfur dust, manufactured by the Koppers products company, is similar to (2) above, but is produced in the manufacture of illuminating gas and is made up of extremely fine sulfur particles.

4.--Kolodust. This is a sulfur dust manufactured by the Niagara sprayer and chemical company. This fungicide is similar to Koloform but is applied as a dust.

5.--Flotation Sulfur Dust. This is a sulfur dust manufactured by the Koppers products company. It is composed of extremely fine particles and is used as a dust.

Applications of Bordeaux and wettable sulfurs have been made with sprayers owned by the nurserymen on whose grounds the trees have been located. The apparatus has varied from a 50 gallon hand operated outfit to a 100 gallon power machine. In different plots the quality of application has necessarily varied somewhat, though every effort has been made to secure the best possible spray coverage. Applications of sulfur dusts were made with a hand duster of standard make capable of throwing dust in a good cloud to a height of 10-12 feet. In dusting, choice of the time of day was made so as to take advantage of dew as a dust holder.

First applications have been made yearly in May or early June, and these have been followed at approximately 3 week intervals by other applications, the last being made in the last half of August. The test plots have, therefore, received treatment 4 to 6 times during each growing season. Emphasis has been laid on the summer treatment, since the so-called "wilt" generally begins to appear in July. Dormant applications have not been tested, since the possible effectiveness of fungicides was unknown.

Results

During and at the end of each season observations on the effectiveness of the various treatments have been made with care. These observations have related primarily, of course, to the usefulness of each fungicide in keeping down the general run of elm diseases included in the term "elm wilt," as used by nurserymen. But other questions have been kept in mind also, such as whether fungicides affect the prevalence of leaf diseases and whether their use is generally beneficial or deleterious to trees. These points are reported on below.

1.--Control of "wilt" diseases. It was realized, when these tests were begun, that curing infections already present would be impossible, unless pruning should prove effective. The measure of the usefulness of each treatment would lie in its ability to prevent the occurrence of new infections. Presumably, the relative values of the different fungicides would be determined also by their relative degrees of success. Whether complete cure and prevention could be attained would be determined from combined fungicide and pruning treatments. Table 1 on the following page shows in brief summary the results now at hand.

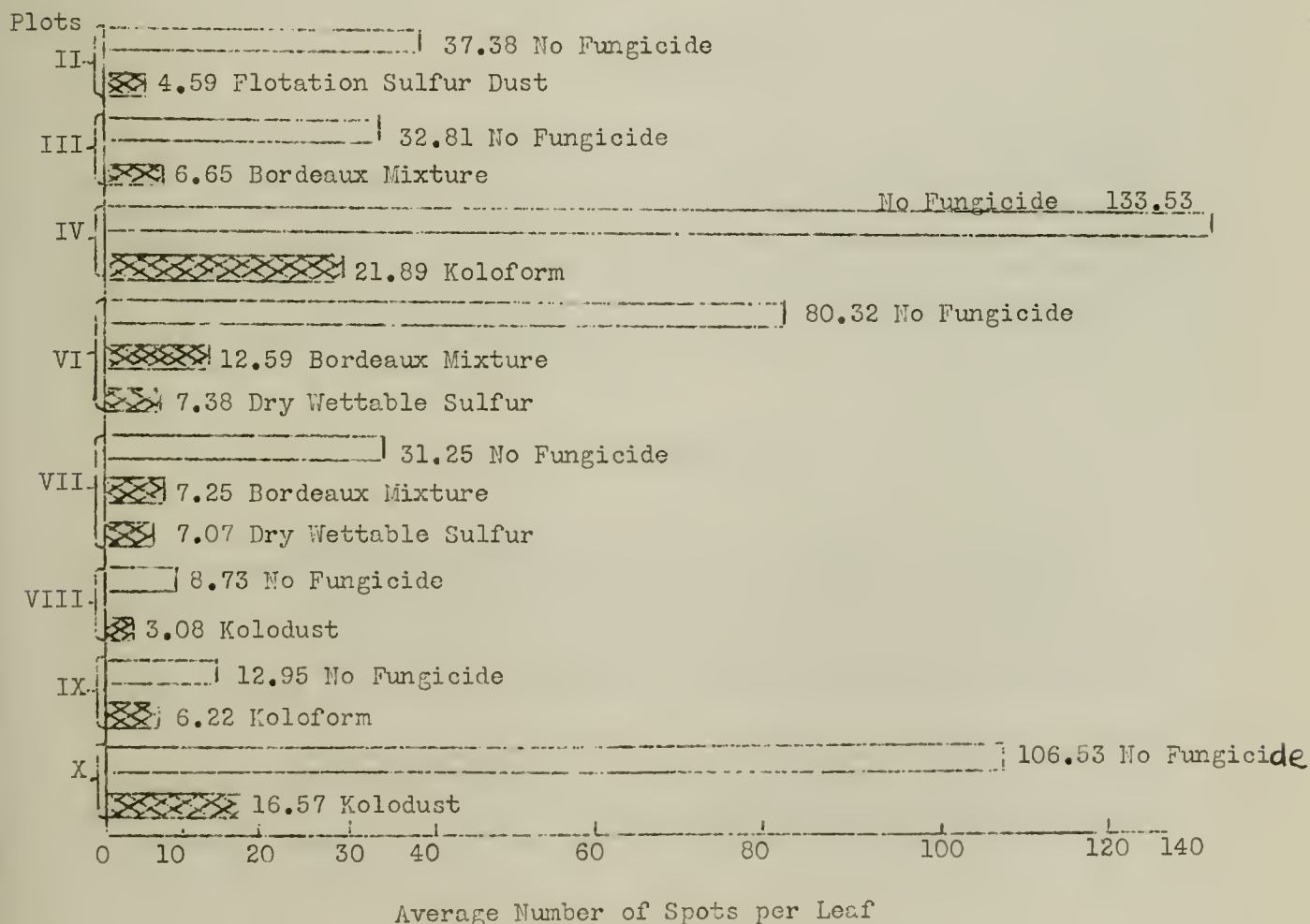
Table 1.--Results of experiments in preventing the occurrence of new infections
by the "wilt" disease fungi, 1931-1935.

Plot	Treatment	Per cent of increase in "wilt" cases over those originally present	Plot	Treatment	Per cent of increase in "wilt" cases over those originally present
II	Flotation sulfur dust	513	III	Bordeaux	300
	Sulfur and pruning	424		Bordeaux and pruning	322
	Pruning	413		Pruning	100
	Check	1231		Check	414
I	Folodust	372	VI	Bordeaux	48
	Check	450		Check	28
VIII	Folodust	284	V	Bordeaux	124
	Folodust and pruning	375		Bordeaux and pruning	147
	Pruning	446		Pruning	575
	Check	461		Check	176
X	Folodust	100	VII	Bordeaux	1700
	Folodust and pruning	128		Check	909
	Pruning	53		Koloform	119
	Check	50		Check	132
VI	Flotation sulfur spray	49	IX	Koloform	223
	Check	28		Check	145
VII	Flotation sulfur	1300	IX	Koloform	8400
	spray Check	909		Check	5550

In general, the use of the sulfur dusts has been accompanied by fewer new wilt infections than has the use of sprays. Flotation sulfur dust has been somewhat more effective than Kolodust, perhaps because it is composed of finer particles and gives a more even coverage of the leaves. The data in table 1 indicate that Bordeaux is somewhat more effective in reducing the number of cases of wilt infection than are either of the two sulfur sprays used. Neither sulfur spray proved materially effective in preventing the occurrence of new cases of wilt infection.

2.--Control of leaf diseases. Leaf diseases, particularly those that result in spotting, occur in varying amounts from one year to another, their abundance and severity depending largely on the prevalence of weather favorable or unfavorable to them. When present in severe amounts, they bring about heavy defoliation at a time when the leaves should be building up a reserve supply of food materials and thus undoubtedly seriously influence

Diagram I. The effectiveness of certain fungicides in reducing the amount of leaf-spotting on elms by parasitic fungi in 1932, a season when this type of injury was exceptionally prevalent.



the growth of trees. They are generally more prevalent and abundant under nursery conditions, because of the short intervals between trees, the shade present, and the more moist atmosphere.

The effectiveness of the fungicides used in our tests on the general prevention of leaf spottings is shown in the preceding diagram, which is based on data very carefully taken in 1932, a season of exceptionally severe leaf spotting.

3.--General effect on growth of trees. In order to determine whether, aside from the control of disease, the use of treatments might have an effect on the growth of trees, the diameter of all trees, both under treatment and in check rows, was taken near the end of the 1934 growing season. A reasonable sale price was established for the several diameters and a money value figured for all plots and treatments. The effect of the treatments can be expressed tentatively in terms of dollars, merely to show what may be realized from the use of treatments in the hands of a nurseryman able to dispose of his stock at a fair price. The estimated money value for each treatment is listed in table 2.

Recommendations

The results thus far obtained in our tests indicate that sulfur dusts can be recommended as practical for summer use, for the purpose of preventing new infections by the so-called elm "wilt" diseases. Sprays, especially the wettable sulfurs, do not, however, appear to be as practical for the same purpose, although good control may sometimes be obtained with them. Where the problem is the prevention of leaf spotting, any of the materials tested will give good results, but the use of dusts may offer some economies in equipment and time.

Instructions

1.--Application of dusts: Sulfur dusts may be applied with a small hand power duster until the trees reach a height of 8-10 feet. Thereafter, a larger apparatus is necessary. Dust should be applied when the foliage is slightly moist, as in the early morning when dew is present or just after a light rain. Dusting when no moisture is present gives poor adherence of the dust and may, moreover, result in burning of the leaves.

2.--Bordeaux mixture must be sprayed onto the trees. Any sprayer that develops sufficient power to force the mixture in a fine mist to the tops of the trees and give good coverage of both leaves and bark will be satisfactory. Both "3-3-50" and "4-4-50" mixtures have been used without injury to the leaves.

Table 2.--Comparative estimate of money value of treated and untreated elm stock.

Age of trees at start	Original number of trees	Duration of experiment, years	Treatment	Estimate of value in 1934	Amount gained or lost by treatment	Calculated gain or loss per 1000 trees
12th season	225	3*	Sulfur dust	\$185.14	\$33.03 gain	\$146.80 gain
	225		" and pruning	159.82	7.71 gain	34.27 gain
	225		Pruning	138.17	13.94 loss	61.95 loss
	225		Check	152.11		
10th season	100	3**	Kolodust	108.67	42.45 gain	424.50 gain
	100		Check	66.22		
3rd season	400	3	Kolodust	76.95	.20 loss	.50 loss
	400		" and pruning	94.52	17.37 gain	43.42 gain
	400		Pruning	87.37	10.22 gain	25.55 gain
	400		Check	77.15		
3rd season	200	3	Kolodust	132.40	.93 gain	4.65 gain
	200		" and pruning	118.47	13.00 loss	65.00 loss
	200		Pruning	108.82	22.65 loss	113.25 loss
	200		Check	131.47		
4th season	300	4	Bordeaux	132.42	22.05 loss	73.50 loss
	300		" and pruning	118.07	36.40 loss	121.33 loss
	300		Pruning	129.37	25.10 loss	83.67 loss
	300		Check	154.47		
7th season	144	4***	Bordeaux	88.97	30.82 loss	214.03 loss
	146		" and pruning	88.97	30.82 loss	211.10 loss
	140		Pruning	82.82	36.97 loss	264.07 loss
	146		Check	119.79		
2nd season	237	3	Bordeaux	142.30	22.13 gain	97.57 gain
	237		" and diseased trees removed	138.85	19.68 gain	83.03 gain
	237		Diseased trees removed	173.40	54.23 gain	228.81 gain
	237		Check	119.17		
9th season	576	3	Bordeaux	577.60	66.82 gain	116.01 gain
	576		Check	510.78		
2nd season	237	3	Sulfur spray	145.80	26.63 gain	112.36 gain
	237		" and diseased trees removed	161.40	42.24 gain	178.18 gain
	237		Check	119.17		
9th season	576	3	Sulfur spray	470.90	39.88 loss	69.23 loss
	576		Check	510.78		
3rd season	1000	3	Koloform	427.75	46.55 gain	46.55 gain
	1000		Check	381.20		
3rd season	347	3	Koloform	143.82	15.45 gain	44.52 gain
	347		Check	128.37		

*Treated for 2 seasons, data taken at end of 3rd season. **Treated for 1 season, data taken at end of 3rd season. ***Treated for 3 seasons, data taken at end of 4th season.

3.--Dry wettable sulfurs are received in the form of dust. They are readily mixed with water, the proportions required being indicated either on the container in which they are received or in instructions furnished by the manufacturers. We have used 15 pounds of Koloform to 100 gallons of water and 7 pounds of dry wettable flotation sulfur to 100 gallons of water.

4.--Times for applications. For the control of the "wilt" diseases, not less than 4 applications should be made each summer. Preferably, the first should be made as soon as the first foliage is out and solidly formed. Subsequent applications may be made at even intervals, spaced according to the number of applications planned but also with due respect to heavy rains, which tend to wash off both sprays and dusts.

When control of leaf spotting is especially desired, applications of either sprays or dusts should be made with reference to new leaf growth, care being taken that new leaves be not left unprotected very long. Applications at 3 week intervals are recommended.

